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SOME PRINCIPLES GOVERNING THE ESTABLISHMENT OF METEOROLOGICAL STATIONS ALONG AIR ROUTES.

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The organization of a meteorological service for an air route involves the solution of two distinct problems:

1. Distribution and grouping of meteorological stations;
2. Communications.

Experience gained in the establishment of two lines, Paris-Warsaw and Constantinople-Bucharest** enables us to establish certain principles, which it may be of interest to note here.

I. Distribution and Grouping of Meteorological Stations.

Before touching upon the study of this question, it is well to recall the principles for laying out an air route. When it is proposed, under existing conditions, to establish a regular airplane transportation service between two points 1500 or 2000 kilometers apart, it is out of the question, for technical and commercial reasons to fly the whole distance without landing.

Therefore the line is divided into sections of 400 to 500 kilometers, terminating in large cities. Airplanes traverse these sections in a single flight. Example: Paris-Strassburg-Prague-Warsaw.

Laying Out the Sections.- A section of an airway should not be regarded as a straight line between two cities (which would be

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** French Aeronautic Mission in the Orient.

a serious mistake), but as a passage-way from 50 to 100 kilometers wide, within which the actual track is determined by experience, that is to say, from a perfect knowledge of conditions in the regions traversed, thus assuring maximum safety by encircling obstacles, flying over the greatest possible number of landing fields, avoiding districts of meteorological disturbances, etc.).

In aviation, a straight line is not the shortest distance between two points, for example: Constantinople-Bucharest by Adrianople and Giurgevo. On this route the itinerary followed by the airplane changes from day to day and from one part of the day to another.

The duty of the meteorological organization consists in supplying at any moment information enabling:

1. The departure of airplanes, when the atmospheric conditions are suitable for flying and landing with safety;

2. The determination of the path to be followed within the strip of territory constituting the section.

Meteorological Organization.- Granting the above, the meteorological organization of a section comprises:

(a) The division of a section into a certain number of zones

These zones are portions of the territory with uniform climatic conditions. Examples: Champagne, Lorraine, the Bavarian plateau, Thuringia.

This division necessitates a very careful meteorological study. In each of these zones a variable number of meteorological stations will be installed.

(b) Types of zone meteorological stations, three types:

1. Central stations for collecting information and making soundings, and mountain stations;

2. Auxiliary observation stations.

(a) Along the route.

(b) For near lateral protection.

3. Stations for distant lateral protection.

Central Stations.

These must coincide as much as possible with regular or emergency landing fields. In each section it is necessary to have at least as many stations of this kind (not including mountain stations) as the average number of hours of flight required for traversing the given section. A station of this type is also established on some summit in every mountainous region traversed. Such stations are provided with complete meteorological outfits. Their personnel comprises at least one meteorologist and one assistant. They can, in particular, make soundings with pilot balloons (or captive balloons). It is assumed that the wind direction and velocity are constant throughout the entire zone within which a station is located, as determined by the soundings.

These stations are connected with the auxiliary observation stations by some suitable means of communication.

Auxiliary Observation Stations.

These stations should be located, some in quincunx formation relative to the median line of a section and at 40 kilometers from

this line, the others (few in number) on the line itself.

It is a common error to wish to increase the number of observation stations on the direct line between two points on the map. This is a result of the error committed in defining the path of an air route and always results in limited information.

These auxiliary stations do not make soundings. Their only duty is to observe cloudiness and visibility. They do not require special apparatus or personnel. It is sufficient to have agents residing in the locality, such as teachers, customs officers, etc.

The aerial navigation companies have decided to maintain a complete system of these stations. Their distribution in quincunx alone enables the utilization of the meteorological information, even two or three hours after the observation. The fundamental difficulty encountered is that of communication. In the usual case of a wind blowing across the section, the lateral stations enable a fairly exact forecast of cloudiness and variations of visibility, in the strip of land included in the section, and, consequently, the determination of the itineraries of the airplanes.

Stations for Distant Lateral Protection.

In order to be able to make forecasts for periods of five or six hours and to protect the line against violent storms, it is necessary to locate meteorological observation stations at distances of from 110 to 150 kilometers from the line. These stations are selected from among those included in the meteorological organization of a country. Example: Line, Paris-Strassburg : Dijon-Maubeuge;

Strassburg-Prague : Frankfort-Munich.

II. Communications.

Since it is important to choose well the location of the stations, to group them in a proper manner and to make careful and frequent observations, it follows that the most difficult problem to solve in the organization of the air routes is the problem of communication. The value of the meteorological service depends on the efficiency of its lines of communication.

It is much less difficult to make observations, than to assemble and make prompt use of them. A meteorological report however is really valuable only at the time of the observation.

It is necessary, therefore, to establish a very complete and perfect system of communications. This can only be brought about gradually. It is by constant effort, great patience and much expense that valuable results can be obtained.

The communication problem consists of two parts:

(a) Assembling the information;

(b) Interpretation and use.

Assembling the Information.

Central stations and mountain stations must be equipped with telephonic and radiotelegraphic systems of communication.

(a) Radiotelegraphy can alone assure sufficiently prompt transmission of information to the other central stations of the line. It alone enables the reception of information from these stations and from the stations for distant lateral protection.

Experience shows that aerial navigation cannot do without a specialized radiotelegraph system, which alone can assure a sufficiently rapid communication for the needs of air traffic and the meteorological service. Such a system is being created in France and in England.

The utilization of non-specialized telegraphic and radiotelegraphic systems in other countries is the source of great difficulties. Communications are intermittent and messages travel too slowly. Moreover, this expedient does not enable communication with airplanes.

(b) The principal and secondary stations are connected by telephone (except in special cases). It is necessary to obtain telephonic priority, which is very troublesome. The communications must be sent out at a certain time for regular observations, aside from which they are only sent as exceptional messages, in case of storm warnings. It is important for these warnings to be transmitted as promptly as possible.

Interpretation and Use.

Assuming that the information is brought together in the desired time, it is important to profit from it as much as possible. First it must be interpreted and then put to the best use. It is necessary for the contact between meteorologist and pilot to be close and constant. It must be recognized that the pilots are very skeptical concerning the accuracy of meteorological information. At the opening of a line, much patience is therefore requir-

ed to win them over and obtain their confidence.

The meteorological information must be presented in as concise and simple a form as possible, easy to assimilate and to use. At each airdrome, the meteorological information received must be posted from hour to hour. The best means consists in having very legible conventional signs on a map, as is done at Le Bourget and in general at all the airdromes of the S.N.Aé (Service de la Navigation Aérienne) in France. But this precaution does not suffice for utilizing the information as a whole. It is dangerous to rely on the memory of the pilots and errors of interpretation are to be feared.

It is necessary to place before the eyes of the pilot, on the airplane itself, a card showing graphically all the information in condensed form and indicating, by way of suggestion, the proper itinerary for him to follow and the altitude at which he should fly. It is also advisable to obtain from pilots their detailed criticism of the information furnished.

With the "Compagnie Franco-Roumaine" I use a graphic system which gives good results. Since the adoption of this system, the pilots have gradually acquired greater confidence in the value of the reports, and furthermore, it is possible to keep strict watch over the work of the meteorological stations.

Communication from Ground to Airplane.

In all of the above, we have supposed that the airplanes did not have radiotelegraph and radiophone apparatus enabling communi-

cations with the ground.

With the approaching use of very large airplanes, necessarily involving radio-electric installations, the meteorological communications will be facilitated. There will also be an exchange of information between the ground and the airplane.

In general, an aviator should receive information from the ground regarding a region an hour before flying over said region (sounding by the central station). This information determines his average altitude of flight. He should also receive the reports from the auxiliary observation stations giving the visibility and the cloudiness, thus enabling the determination of his itinerary.

This precaution is fundamentally important for the landing zone at the terminal. In fact, it must be ascertained whether the visibility is sufficient. The duty of the navigator aboard the airplane is to interpret this information and inform the pilots as to the proper route. Furthermore, instruments like the "navigraph" of Mr. Le Prieur, enable accurate checking up of the route followed. It also enables at any instant the determination of the air speed. We can therefore conceive of the possibility of accurate observations aboard such an airplane, which would constitute a veritable flying observatory. There will then be a means of checking ground observations on the airplane from which other airplanes flying over the course can profit greatly. This advantage, especially in foreign countries, will partially offset the lack of satisfactory ground meteorological service. The times for making

the soundings must be determined by definite instructions. They must precede, at each point, the regular passage of the airplane by an hour. On the other hand, ground stations must always be ready to reply to questions from an airplane. The aviators must listen frequently for short periods, in order to allow the ground stations to send them particularly urgent information, especially storm warnings.

Such are the principles, learned by experience, which must guide us in the organization of a meteorological service.

Translated by the National Advisory Committee for Aeronautics.